

AL-1.1599

C-2

**January 1999**



# ***Mathematics 33***

## ***Grade 12 Diploma Examination***

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January 1999

# Mathematics 33

## Grade 12 Diploma Examination

### Description

Time: 2.5 h. This examination was developed to be completed in 2.5 h; however, you may take an additional 0.5 h to complete the examination.

This is a **closed-book** examination consisting of

- 37 multiple-choice and 12 numerical-response questions, of equal value, worth 70% of the examination
- 4 written-response questions worth 30% of the examination

This examination contains sets of related questions.

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

A mathematics data booklet is provided for your reference.

**Note:** *The perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.*

### Instructions

- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- Read each question carefully.
- If you wish to change an answer, erase **all** traces of your first answer.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

### Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

### Example

This examination is for the subject of

- A.** biology  
**B.** physics  
**C.** chemistry  
**D.** mathematics

## Answer Sheet

(A) (B) (C) ☒

### Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.7), then be sure to record the 0 before the decimal place.
- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

## Examples

### Calculation Questions and Solutions

The value of  $\tan 35^\circ$  to the nearest tenth is

(Record your answer in the numerical-response section on the answer sheet.)

Calculator value: 0.7002075

Value to be recorded: 0.7

**Record 0.7 on the  
answer sheet —**

0	.	7	
	●	•	
●	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	●	7
8	8	8	8
9	9	9	9

The constant term in the quadratic function  $y = 2x^2 + 7x + 32$  is \_\_\_\_\_.  
(Record your answer in the numerical-response section on the answer sheet.)

Value to be recorded: 32

Record 32 on the answer sheet →

3	2		
---	---	--	--

•	•		
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

### Correct-Order Question and Solution

When the following subjects are arranged in alphabetical order, the order is \_\_\_\_\_.

- 1 biology
- 2 physics
- 3 chemistry
- 4 mathematics

(Record **all four digits** of your answer in the numerical-response section on the answer sheet.)

Value to be recorded: 1342

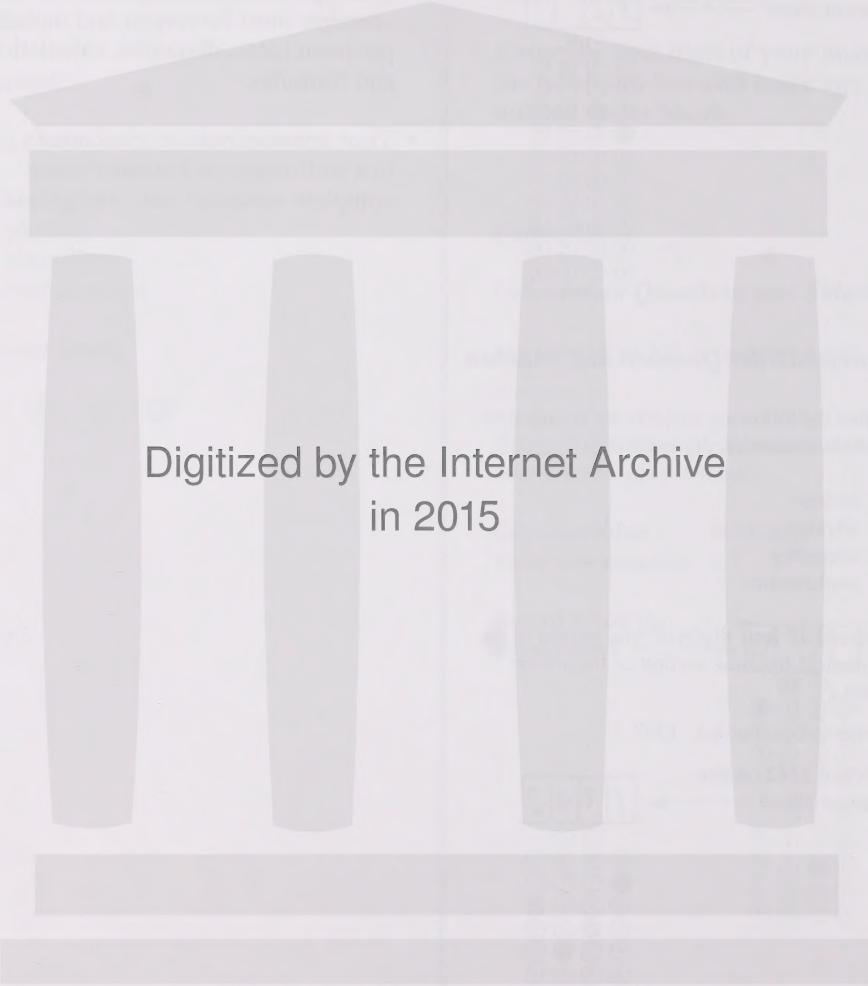
Record 1342 on the answer sheet →

1	3	4	2
---	---	---	---

•	•		
0	0	0	0
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
6	6	6	6
7	7	7	7
8	8	8	8
9	9	9	9

### Written Response

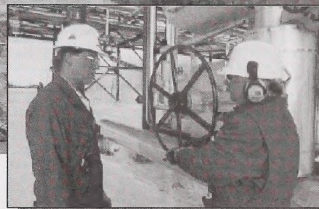
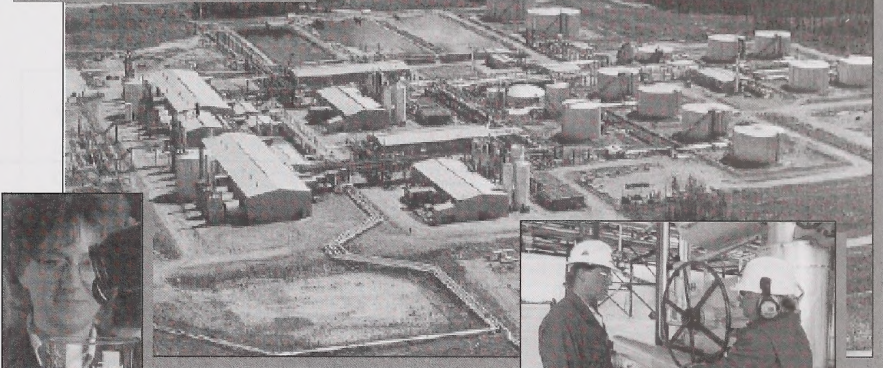
- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must address **all** aspects of the question.
- Descriptions and/or explanations of concepts must be correct and include pertinent ideas, diagrams, calculations, and formulas.
- Your answers must be presented in a well-organized manner using complete sentences and correct units.



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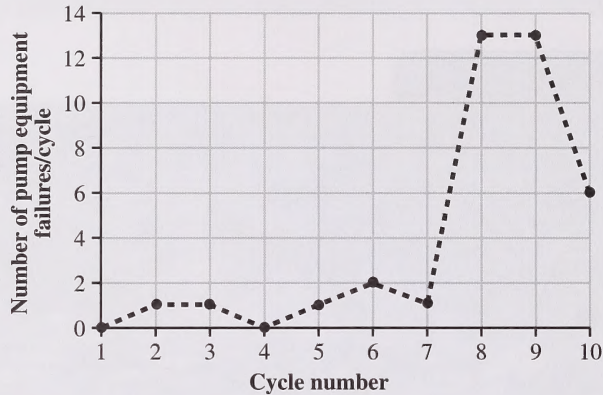
## ALBERTA INDUSTRY

Mathematics is used in various ways in the Alberta Oil Industry. The first set of questions is related to the financial, analytical, and technical concerns of an oil company at its plant and well sites.



Use the following information to answer the next question.

In order for underground oil to be pumped to the surface, it must be heated with steam at recurring intervals of time called “steaming cycles.” Using the graph below, a technologist graphed the number of pump equipment failures during each of ten steaming cycles at a set of oil wells.



1. The technologist recognized that the greatest change in the number of pump equipment failures occurred between cycle numbers
  - A. 1 and 2
  - B. 5 and 6
  - C. 7 and 8
  - D. 9 and 10

Use the following information to answer the next question.

The technologist also determined the voltage in a given electrical circuit by using the quadratic function  $V(t) = t^2 - 12t + 40$ , where  $t$  is the time, in seconds, and  $V(t)$  is the voltage, in volts.

### Numerical Response

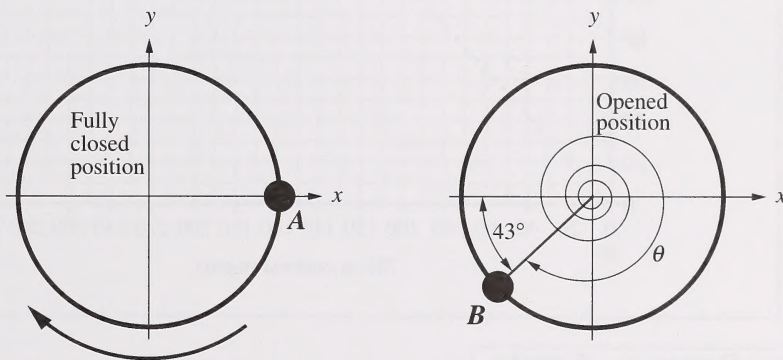
1. When the time,  $t$ , is 9.1 seconds, the voltage  $V(t)$ , correct to the nearest tenth of a volt, is \_\_\_\_\_ volts.

(Record your answer in the numerical-response section on the answer sheet.)

\_\_\_\_\_

Use the following information to answer the next question.

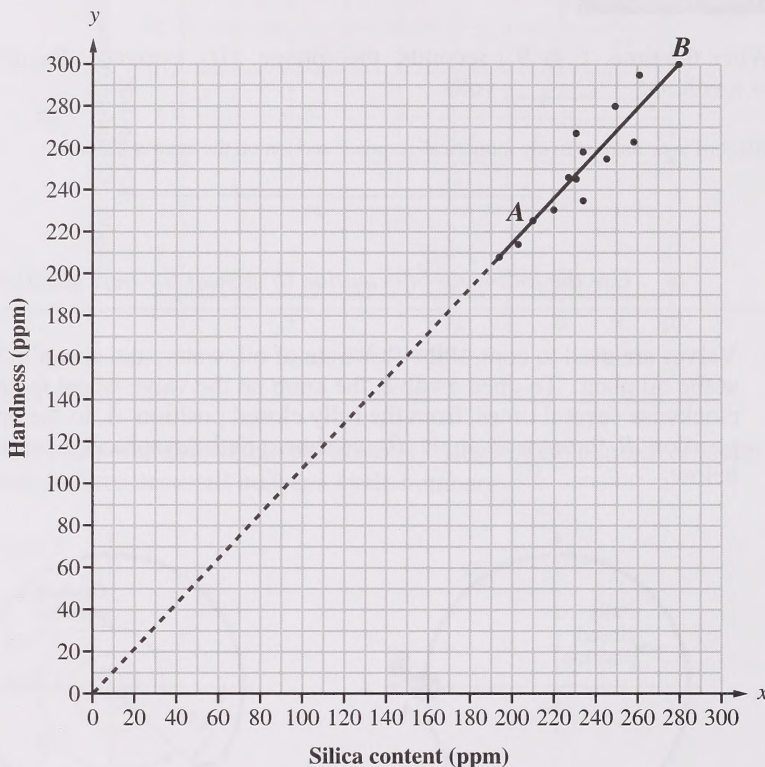
Valves are used to control the flow rate of oil, water, and steam in the pipes at the oil plant. To open a valve, the knob on the valve wheel is rotated clockwise several times, from the fully closed position  $A$  to the opened position  $B$  through an angle  $\theta$ , as shown in the graphical representation below.



2. Given the information above, the measure of the rotational angle,  $\theta$ , that the knob moves through from position  $A$  to position  $B$  is
- A.  $-1\,217^\circ$
  - B.  $-857^\circ$
  - C.  $857^\circ$
  - D.  $1\,217^\circ$

Use the following information to answer the next question.

To ensure that recycled water at the oil plant is pure enough for use, another technologist analyzed the scatter plot below to determine the relationship between the hardness (mineral content) of the water, in parts per million (ppm), and the silica content of the water, in parts per million (ppm). A line of best fit is also included below.



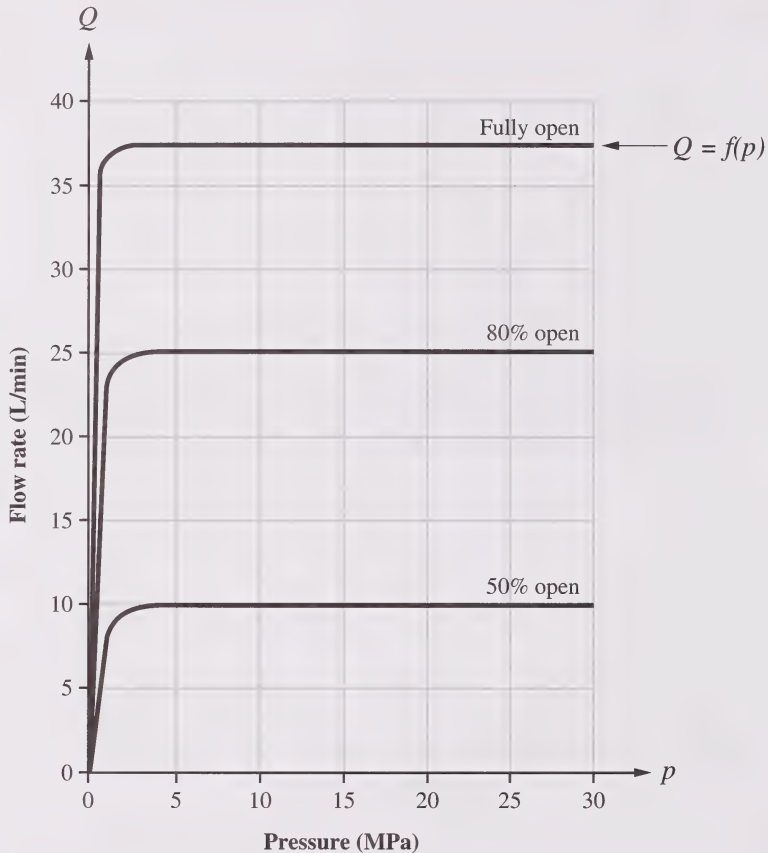
**Written Response — 5 marks**

1. a. If the silica content of a water sample is 240 ppm, then according to the line of best fit, the hardness of the water sample is \_\_\_\_\_ ppm.

- b. When she analyzed the scatter plot, the technologist remarked, “There appears to be a relatively strong positive correlation between the hardness and the silica content of the water at this plant.” Explain why the correlation is strong and positive.
- c. Using the two points  $A(210, 225)$  and  $B(280, 300)$ , determine the slope of the line of best fit,  $m$ , and write its equation in the form  $y = mx + b$ . Support your answer mathematically.

Use the following information to answer the next question.

The graph of the function  $Q = f(p)$  and two of its related graphs are shown below. Each graph portrays the relationship between the flow rate,  $Q$ , in litres per minute, and the pressure,  $p$ , in megapascals, of oil passing through a valve opened a particular amount.



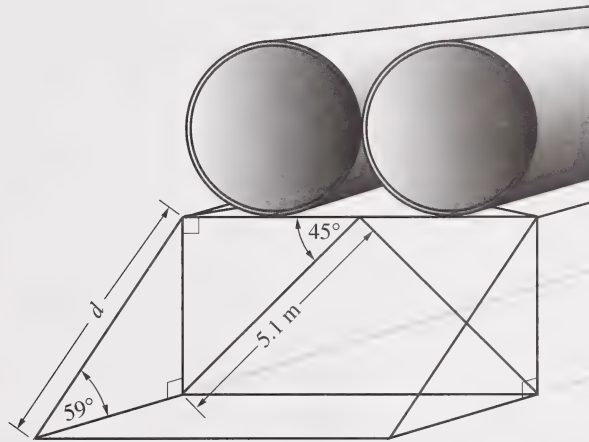
### Numerical Response

2. At a pressure of 20 megapascals, the **difference** between the flow rates through the valve opened 80% and the valve opened 50%, to the nearest whole litre per minute, is \_\_\_\_\_ L/min.

(Record your answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

A support structure for pipes that carry heated oil to the oil plant is shown below.



3. Based on the information above, the length of support  $d$ , to the nearest tenth of a metre, is
- A. 3.1 m  
B. 3.6 m  
C. 4.2 m  
D. 6.0 m
- 

Use the following information to answer the next question.

One part of a different support structure is in the shape of an isosceles triangle. The two equal angles each measure  $50^\circ$ , and the two equal sides each measure 75 cm.

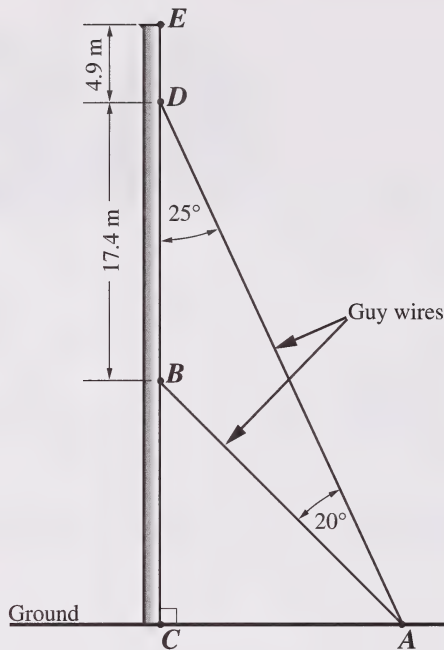
### Numerical Response

3. The length of the side that is opposite the  $80^\circ$  angle, to the nearest tenth centimetre, is \_\_\_\_\_ cm.

(Record your answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

A flare stack at the oil plant has a set of guy wires attached to it at the ground, as shown below.



**Written Response — 6 marks**

- 2.** a. Calculate the missing measures of  $\angle DBA$ ,  $\angle ABC$ , and  $\angle BAC$ , and **indicate** these measures on the diagram above.

- b. Determine the length of **one** of the guy wires,  $\overline{AB}$  or  $\overline{AD}$ , to the nearest tenth of a metre. Support your answer mathematically.

- c. Determine the height of the flare stack,  $\overline{CE}$ , and state your final answer to the nearest tenth of a metre.

Use the following information to answer the next question.

To calculate the rate of flow of oil from a well hole, a technologist used the equation  $0.15Q^2 - 5.7Q - 18.3 = 0$ , where  $Q$  is the rate of flow in cubic metres per day.

To solve the equation, the technologist used the quadratic formula to work through the following steps.

$$\text{Step I} \quad Q = \frac{-(-5.7) \pm \sqrt{(-5.7)^2 - 4(0.15)(-18.3)}}{2(0.15)}$$

$$\text{Step II} \quad Q = \frac{5.7 \pm \sqrt{32.49 + 10.98}}{0.30}$$

$$\text{Step III} \quad Q = \frac{5.7 \pm \sqrt{43.47}}{0.30}$$

$$\text{Step IV} \quad Q = 5.7 \pm 21.98$$

4. The technologist made an error in
- A. step I
  - B. step II
  - C. step III
  - D. step IV

Use the following information to answer the next question.

Equipment used in the refining of oil is delivered by truck to the oil plant from a supplier located 1 500 km away. It takes 2.5 hours more for a loaded truck to travel the 1 500 km, than it does for an empty truck. Additionally, when the truck is empty, it travels 25 km/h faster. If  $x$  represents the speed of the loaded truck, then the time, in hours, required for the loaded truck to travel 1 500 km can be represented by the rational expression

$$\frac{1\,500}{x + 25} + \frac{5}{2}$$

5. A simplified form of this rational expression is

A.  $\frac{1\,505}{x + 27}$

B.  $\frac{1\,505}{2(x + 25)}$

C.  $\frac{3\,025 + 5x}{2(x + 25)}$

D.  $\frac{3\,125 + 5x}{2(x + 25)}$

Use the following information to answer the next two questions.

A 100 million dollar oil project is to begin construction some time within the next ten years. To ensure that 100 million dollars is available for starting construction in any particular year, the company's project manager examined the graphs below, which illustrate the amount of money that would need to be initially invested in 1999 at three different interest rates ( $i$ ).



For example, if construction was to begin in the year 2004, then for an interest rate of 20% per annum (middle graph), about 40 million dollars must be invested in 1999.

6. Based on the above information, the project manager realized that for a particular
- construction starting year, as the interest rate increases, the money initially invested increases
  - construction starting year, as the interest rate increases, the money initially invested decreases
  - interest rate, there is a quadratic relationship between the money initially invested and the construction starting year
  - interest rate, there is a linear relationship between the money initially invested and the construction starting year

7. For a construction starting year of 2006, the **difference** in the amount of money that would have to be initially invested at an interest rate of 10% per annum and the amount of money that would have to be initially invested at an interest rate of 20% per annum, is approximately
- A. \$23 000 000
  - B. \$28 000 000
  - C. \$35 000 000
  - D. \$51 000 000
- 

*Use the following information to answer the next question.*

In order for an employee to assist the project manager, she had to relocate closer to the job site. To purchase a new house, the employee arranged a \$92 000 mortgage over 15 years.

#### **Numerical Response**

4. If the monthly mortgage payments were arranged to be \$784.83, then the annual interest rate on the mortgage, to the nearest hundredth of a percentage, is \_\_\_\_\_%.

(Record your answer in the numerical-response section on the answer sheet.)

*Use the following information to answer the next question.*

To have more money available for retirement, one of the senior executives of the oil company planned to save \$20 000 over 3 years. His plan consisted of making regular monthly payments at the beginning of each month into the company's annuity, which earned 6% per annum compounded monthly.

8. By referring to an Amount of an Annuity Table, the executive determined that his regular monthly payments would be
- A. \$158.39
  - B. \$505.91
  - C. \$555.56
  - D. \$608.44
- 

*Use the following information to answer the next question.*

Management at the oil company asked a statistician to set up a survey to determine customer satisfaction. The following steps were completed to conduct the survey.

- 1 Design a survey questionnaire
- 2 Draw inferences from the survey responses
- 3 Analyze the data from the survey
- 4 Collect and organize the data from the survey responses

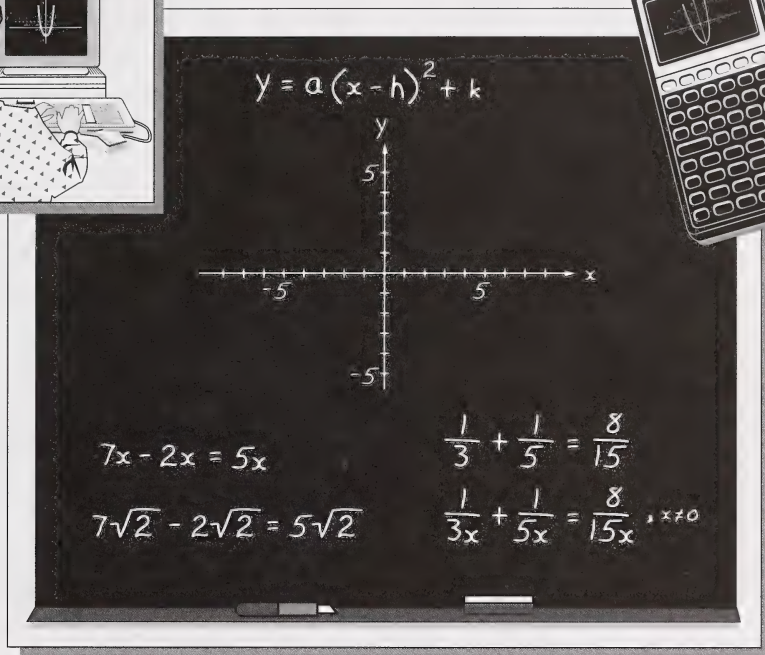
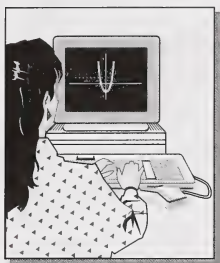
### **Numerical Response**

5. The order in which the above steps must be completed to conduct the survey is \_\_\_\_, \_\_\_\_, \_\_\_\_, and \_\_\_\_.

(Record **all four digits** of your answer in the numerical-response section on the answer sheet.)

## CONNECTIONS

Skills acquired in working with functions and polynomials can be connected to procedures used in simplifying rational, radical, and quadratic expressions. Apply these skills and your understanding of the relationships between functions and their graphical representations to answer the next set of questions.



**Numerical Response**

6. In the expression  $\frac{3x(x + 4.50)}{(x + 1.50)(5.75 - x)(x + 2.85)}$ , the **positive** non-permissible value for  $x$ , to the nearest hundredth, is \_\_\_\_\_.

(Record your answer in the numerical-response section on the answer sheet.)

*Use the following information to answer the next question.*

To simplify the rational expression  $\frac{2x^2 - x - 15}{x^2 - 9}$ , a student worked through the following two steps.

$$\text{Step I} \quad \frac{(2x - 5)(x + 3)}{(x - 3)(x + 3)}$$

$$\text{Step II} \quad \frac{2x - 5}{x - 3}, x \neq \pm 3$$

9. What error did the student make in the simplification process?
- A. The numerator was factored incorrectly in step I.
  - B. The denominator was factored incorrectly in step I.
  - C. The final answer was reduced incorrectly from step I to step II.
  - D. The non-permissible values for  $x$  were stated incorrectly in step II.

10. A simplified form of  $\frac{m^2 - 16}{3m - 9} \times \frac{m^2 - 6m + 9}{2m^2 - 11m + 12}$ , where  $m \neq \frac{3}{2}$ , 3, or 4, is

A.  $\frac{m + 4}{3}$

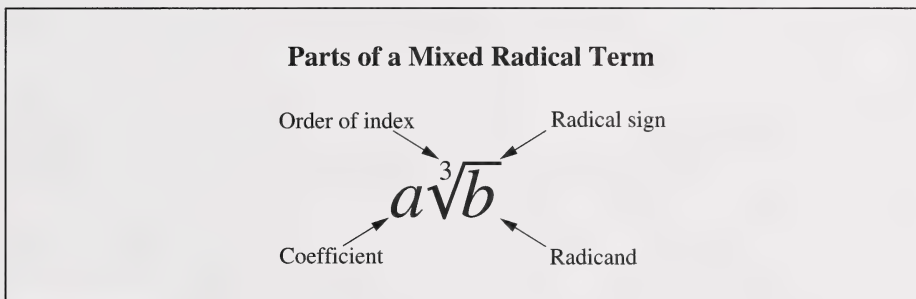
B.  $\frac{m + 4}{6}$

C.  $\frac{m + 4}{3(2m - 3)}$

D.  $\frac{(m + 4)(m - 3)}{3(2m - 3)}$

11. The lowest common denominator for the expression  $\frac{x+4}{x^2-3x} + \frac{x+5}{x^2-x-6}$ , where  $x \neq 3, 0$ , or  $-2$ , is
- A.  $(x-3)(x+2)$   
 B.  $x(x-3)(x+2)$   
 C.  $x(x-3)(x-3)(x+2)$   
 D.  $x(x-3)(x-2)(x+3)$

Use the following information to answer the next question.



### Numerical Response

7. When  $\sqrt[3]{80}$  is expressed as a mixed radical in the form  $a\sqrt[n]{b}$ , where  $a$  and  $b$  are whole numbers greater than 1, the value of the radicand is \_\_\_\_\_.

(Record your answer in the numerical-response section on the answer sheet.)

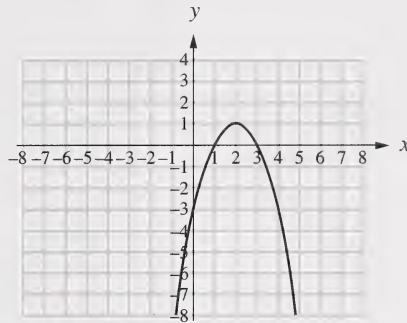
\_\_\_\_\_

12. If the radical expression  $\frac{2}{3}\sqrt{18} - \frac{3}{2}\sqrt{108}$  is simplified to the form  $a\sqrt{2} + b\sqrt{3}$ , where  $a$  and  $b$  are integers, the values of  $a$  and  $b$  are, respectively,
- A. 6 and  $-54$   
 B. 4 and  $-6$   
 C. 2 and  $-18$   
 D. 2 and  $-9$

13. If  $\frac{9+\sqrt{21}}{\sqrt{3}}$  is rationalized to the equivalent form  $3\sqrt{3} + c\sqrt{d}$ , where  $c$  and  $d$  are whole numbers, then the value of  $d$  is
- A. 3
  - B. 7
  - C. 18
  - D. 21
14. In order to solve the radical equation  $\sqrt{x+9} = x+5$ , where  $x > -5$ , a student could convert it to the quadratic equation
- A.  $x^2 - x + 34 = 0$
  - B.  $x^2 - x + 16 = 0$
  - C.  $x^2 + 9x - 34 = 0$
  - D.  $x^2 + 9x + 16 = 0$

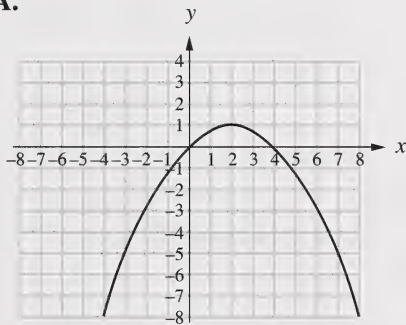
Use the following information to answer the next question.

The graph of a quadratic function  $y = a(x - h)^2 + k$ , where  $a = -1$ ,  $h > 0$ , and  $k > 0$ , is shown below.

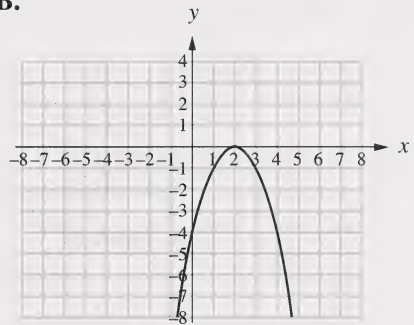


15. Which of the following graphs could represent a graphical transformation of the graph above if only the value of parameter  $a$  is changed?

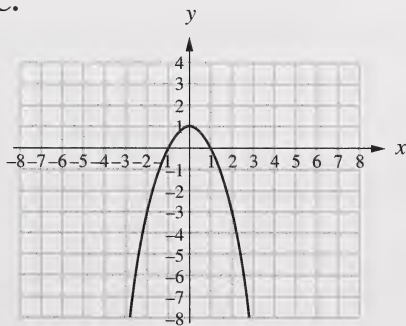
A.



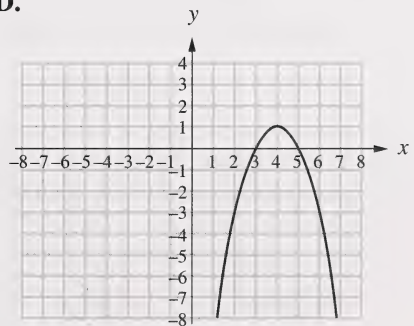
B.



C.



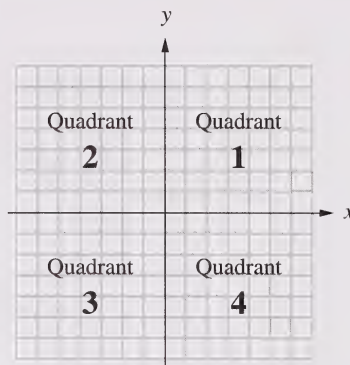
D.



Use the following information to answer the next question.

The following four quadratic functions can be graphed on the coordinate plane shown below. The vertex of each graph would be located in one of the four quadrants.

Quadratic Functions
$y = (x + 3)^2 + 1$
$y = (x - 4)^2 + 1$
$y = (x - 3)^2 - 2$
$y = (x + 4)^2 - 2$



### Numerical Response

8. Match each quadrant, as numbered above, with its corresponding statement.

The vertex of the graph of  $y = (x + 3)^2 + 1$  would be found in quadrant \_\_\_\_\_ . (Record in the **first** column.)

The vertex of the graph of  $y = (x - 4)^2 + 1$  would be found in quadrant \_\_\_\_\_ . (Record in the **second** column.)

The vertex of the graph of  $y = (x - 3)^2 - 2$  would be found in quadrant \_\_\_\_\_ . (Record in the **third** column.)

The vertex of the graph of  $y = (x + 4)^2 - 2$  would be found in quadrant \_\_\_\_\_ . (Record in the **fourth** column.)

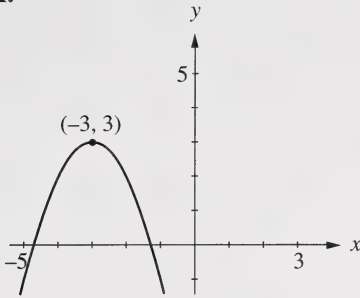
(Record **all four digits** of your answer in the numerical-response section on the answer sheet.)

\_\_\_\_\_

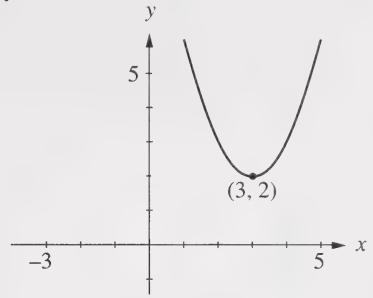
16. If the function represented by the graph of  $y = ax^2 + bx + c$ , where  $a \neq 0$ , has a minimum value of  $-2$ , then the number of its  $x$ -intercepts is
- A. zero
- B. one
- C. two
- D. three

17. Which of the following graphs of quadratic functions has an axis of symmetry whose equation is  $x - 3 = 0$ ?

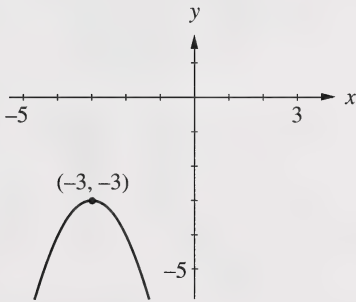
A.



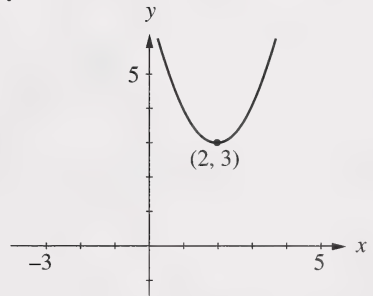
B.



C.



D.

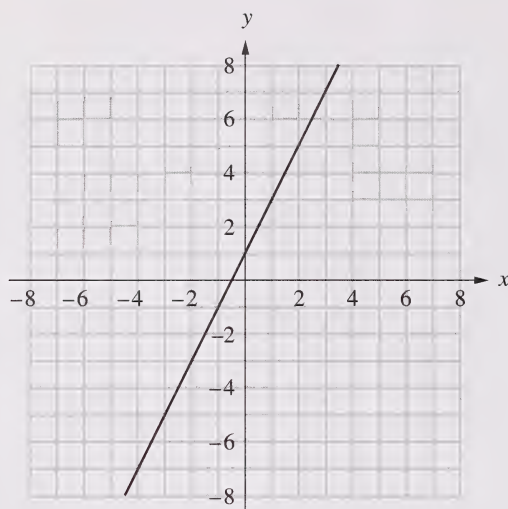


18. If  $f(x) = -x^2 + 3x - 5$ , then  $f(a)$ , where  $a \neq 0$ , could be represented by

- A.  $-a^2 + 3a - 5$
- B.  $a^2 + 3a - 5$
- C.  $-(ax)^2 + 3(ax) - 5$
- D.  $(ax)^2 + 3(ax) - 5$

Use the following information to answer the next question.

A student realized that equations or graphs can be used to find the inverse of linear functions. The equation  $y = 2x + 1$  is graphically represented below.



19. The inverse of the function  $y = 2x + 1$  is

- A.  $y = 2x + \frac{1}{2}$
- B.  $y = 2x - 1$
- C.  $y = \frac{1}{2}x + 1$
- D.  $y = \frac{1}{2}x - \frac{1}{2}$

## SPORTS AND RECREATION

People who prepare races or who coach, train, or finance athletes use mathematics to represent, analyze, and interpret many aspects of winter Olympic sports such as cross-country skiing and biathlon. The next twelve questions are related to these applications.



*Use the following information to answer the next question.*

Over a 10 km cross-country ski course, a skier found that his average speed in icy conditions is 4 km/h faster than his average speed in powder snow conditions. As well, his time is 5 minutes faster. The coach represented the speed of the skier in these two snow conditions with the following algebraic terms.

$x$  = Average speed of skier in powder snow conditions

$x + 4$  = Average speed of skier in icy conditions

The coach also wrote the following equation relating the times of the skier.

$$\frac{10}{x} - \frac{10}{x + 4} = \frac{1}{12}$$

**Written Response — 5 marks**

- 3.** a. In the equation above, the expression that represents the time required for this skier to complete a 10 km cross-country ski course in powder snow conditions is \_\_\_\_\_.
- b. Explain what  $\frac{1}{12}$  represents in the equation above.

*Use the following additional information to answer the next question.*

The coach simplified the equation to  $x^2 + 4x - 480 = 0$ .

- c. Show how you would solve this quadratic equation to find  $x$ , and then use your solution to determine the skier's average speed **in icy conditions**.

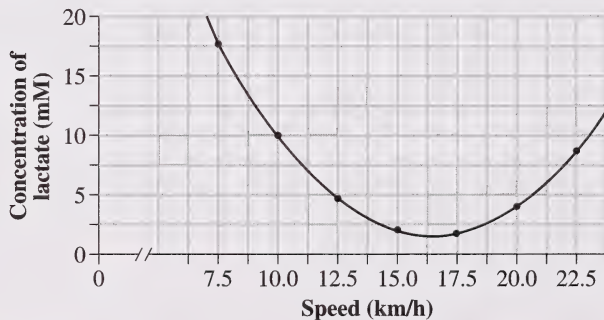
Use the following information to answer the next question.

A physiologist collected data and plotted a scatter plot relating the speed of a cross-country skier over a 10 km race to the volume of oxygen she consumed. After analyzing the scatter plot, the physiologist inferred that as the skier's speed increased, the volume of oxygen she consumed increased.

20. From the physiologist's inference, the apparent correlation of the scatter plot is
- A. zero
  - B. positive
  - C. negative
  - D. undefined
- 

Use the following information to answer the next question.

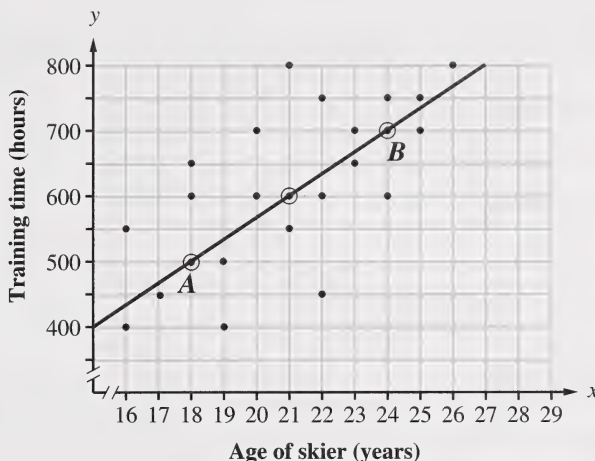
To determine a skier's level of fatigue, the physiologist measured the concentration of lactate built up in the skier's blood when skiing at various speeds. She illustrated this data in the graph below and included a best fit curve.



21. The relationship between the concentration of lactate in a skier's blood and the skier's speed is **best** described as
- A. linear
  - B. quadratic
  - C. reciprocal
  - D. exponential

Use the following information to answer the next question.

The scatter plot below relates the age of various cross-country skiers to the hours of training that they completed in a particular year. A median line of best fit and three median points are also included.



### Numerical Response

9. If the line of best fit passes through the points  $A(18, 500)$  and  $B(24, 700)$ , then the slope of the line, to the nearest tenth, is \_\_\_\_\_.

(Record your answer in the numerical-response section on the answer sheet.)

\_\_\_\_\_

Use the following information to answer the next question.

The financial manager of a biathlon team took out a loan for \$3 950 to buy some new training equipment. The loan was carried over 2 years at 8.75% per annum.

### Numerical Response

10. The regular monthly payment on this loan, to the nearest dollar, is \$\_\_\_\_\_.

(Record your answer in the numerical-response section on the answer sheet.)

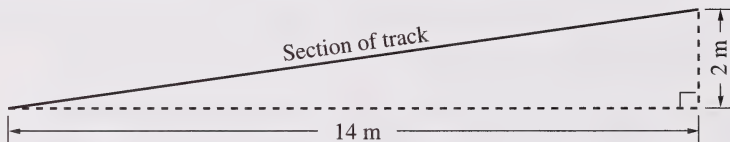
Use the following information to answer the next question.

In order to pay for the biathlon team's Olympic expenses, a sponsor for the team deposited \$1 309.32 at the beginning of every month into an annuity account that earned 12% per annum compounded monthly.

22. The number of months it will take the sponsor to save \$46 000.00 is
- A. 14 months
  - B. 27 months
  - C. 30 months
  - D. 35 months
- 

Use the following information to answer the next question.

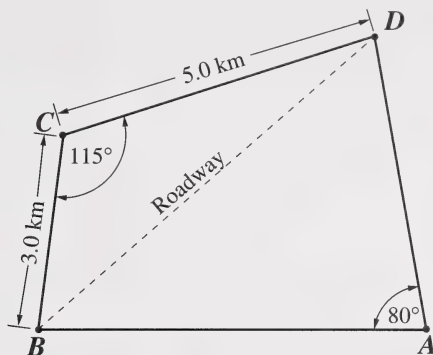
A course designer for a biathlon needed to ensure that the slope of the track varied throughout the course. A section of track rose 2 m in elevation over a horizontal distance of 14 m, as shown below.



23. If the length of this section of track, in metres, is expressed in the form  $a\sqrt{b}$ , where  $a$  and  $b$  are whole numbers greater than 1, then the smallest whole number value that  $b$  could be is
- A. 2
  - B. 3
  - C. 8
  - D. 10

Use the following information to answer the next question.

The course manager needed to clear the snow on a roadway used to transport people and equipment between the checkpoints labelled  $B$  and  $D$  of the biathlon course, as shown below.



24. An equation that could be used to determine the length of the roadway,  $\overline{BD}$ , is

- A.  $\overline{BD} = \frac{3.0 \sin 115^\circ}{\sin 80^\circ}$
- B.  $\overline{BD} = \frac{5.0 \sin 115^\circ}{\sin 80^\circ}$
- C.  $\overline{BD} = \sqrt{3.0^2 + 5.0^2 - 2(3.0)(5.0) \cos 115^\circ}$
- D.  $\overline{BD} = \sqrt{3.0^2 + 5.0^2 + 2(3.0)(5.0) \cos 115^\circ}$

Use the following information to answer the next two questions.

In a biathlon, competitors shoot at 20 targets. Based on many biathlon results, a particular biathlete hits 75% of all targets.

25. If a 90% confidence interval for the number of hits is assumed, it is **unlikely** in a randomly selected set of 20 targets that the biathlete will hit
- A. 17 targets
  - B. 15 targets
  - C. 13 targets
  - D. 10 targets
26. If the target hitting data for this biathlete is organized into a 70% box plot, then the percentage of data that the confidence interval represents is
- A. 14%
  - B. 30%
  - C. 70%
  - D. 90%
- 

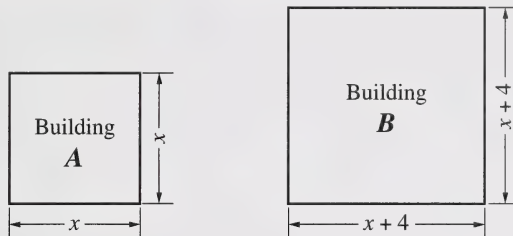
### Numerical Response

11. When biathletes miss a target, they must ski around a circular penalty loop. If a biathlete travelling at a constant speed completes the circular penalty loop in 20 seconds, then the measure of the angle that the biathlete skies through in 18 seconds, to the nearest degree, is \_\_\_\_\_°.

(Record your answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next question.

The financial manager of the biathlon team rented two buildings for biathletes to use while in training. Both buildings are square and the length of the sides of building *B* is 4 metres longer than the length of the sides of building *A*, as shown below. The **total** area of the two square buildings is  $976 \text{ m}^2$ .

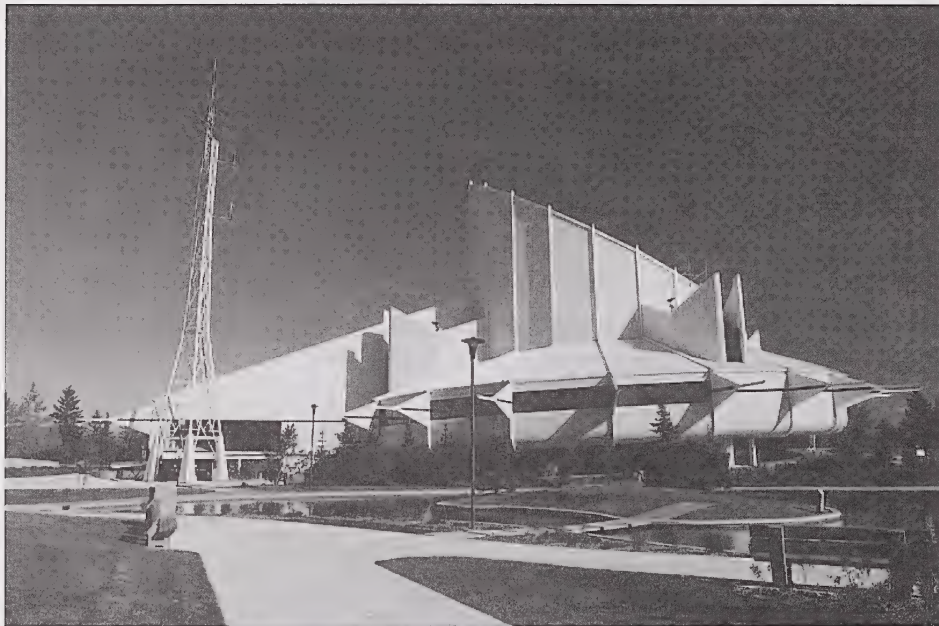


27. If the length, in metres, of each side of building *A* is represented by  $x$ , then an equation that could be used to determine  $x$  is

- A.  $(x + x + 4)^2 = 976$
- B.  $x^2 - (x + 4)^2 = 976$
- C.  $(x + 4)^2 - x^2 = 976$
- D.  $x^2 + (x + 4)^2 = 976$

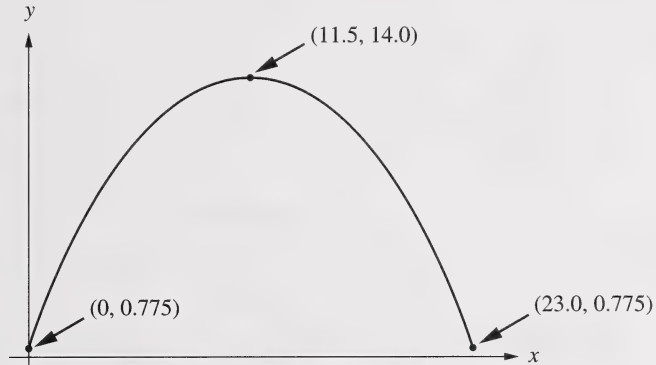
## SPACE SCIENCE

School groups visit the Edmonton Space & Science Centre. As students tour the facilities, they learn about many mathematical applications related to science. Solve the following set of questions related to construction characteristics, operations, and activities associated with the Edmonton Space & Science Centre.



Use the following information to answer the next question.

The cross-section shown below of the viewing dome in the Space & Science Centre has a parabolic shape. This parabolic shape can be represented by the function  $y = a(x - h)^2 + k$ , where  $y$  is the vertical height, in metres, and  $x$  is the horizontal length, in metres.



28. The graph above can be represented by the equation  $y = a(x - h)^2 + k$  where the value of  $k$  is

- A. 0.775
- B. 11.5
- C. 14.0
- D. 23.0

Use the following information to answer the next question.

Projectors around the perimeter of the viewing dome project images onto the dome. The relationship of the light intensity,  $I$ , in lux, to the distance from a projector lamp to an image,  $r$ , in metres, is expressed by the formula

$$I = \frac{716}{r^2}$$

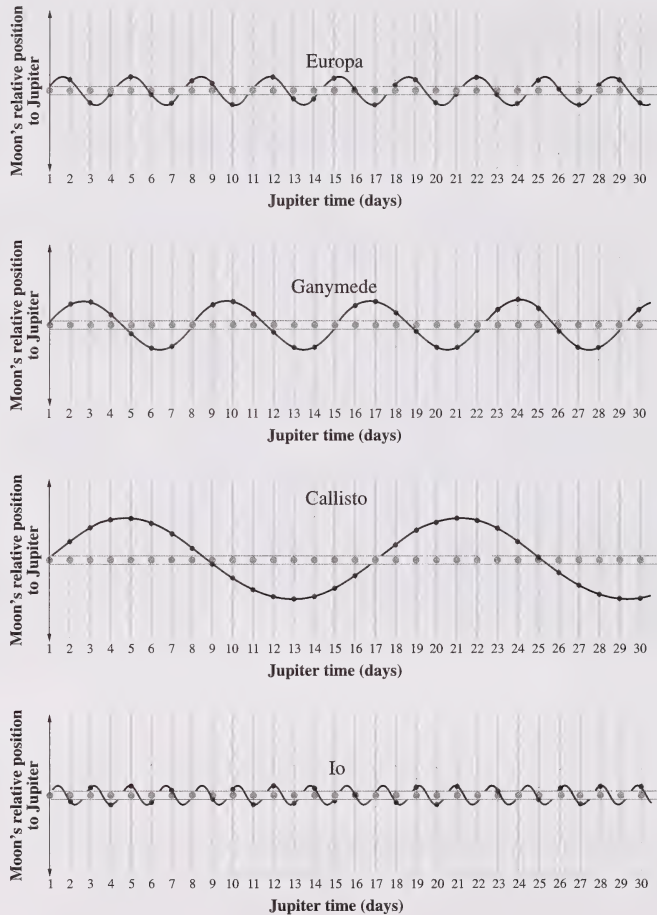
### Numerical Response

12. If the distance from a projector lamp to an image is 25.5 metres, then the light intensity of the image, to the nearest tenth, is \_\_\_\_\_ lux.

(Record your answer in the numerical-response section on the answer sheet.)

Use the following information to answer the next two questions.

One of the displays at the Space & Science Centre portrays the relative positions of Jupiter's moons Europa, Ganymede, Callisto, and Io, with respect to telescopic observations of Jupiter over a period of one month. The graphs are similar in appearance to the graph of a sine function, and each moon's path is graphed on the same scale, as shown below.



29. The graph with the greatest amplitude is the one representing the moon
- A. Io
  - B. Europa
  - C. Callisto
  - D. Ganymede

30. The graph with the shortest period is the one representing the moon
- A. Io
  - B. Europa
  - C. Callisto
  - D. Ganymede
- 

*Use the following information to answer the next question.*

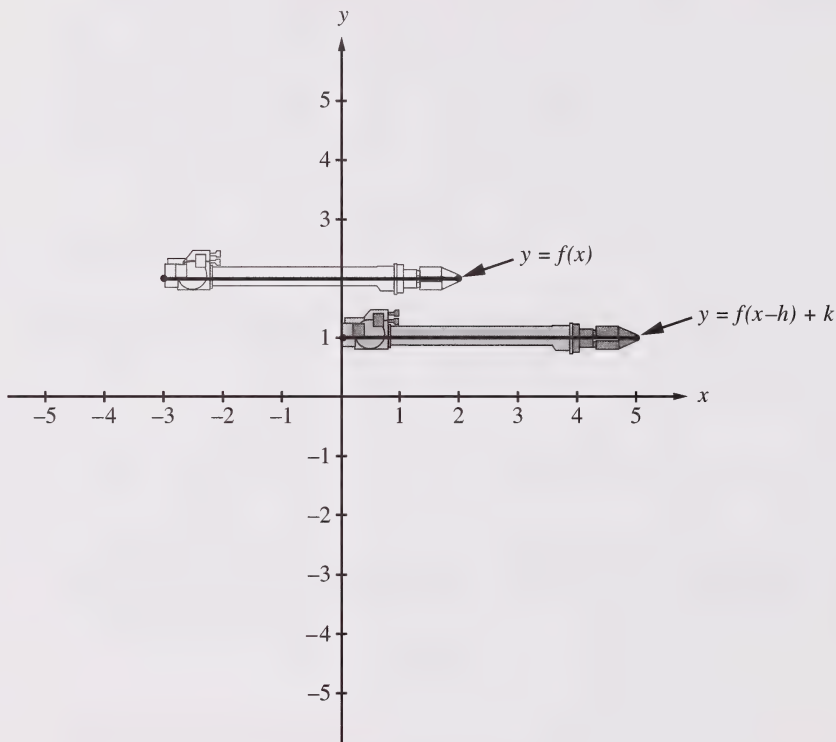
Another display illustrates how artificial gravity is created on space stations by the rotation of the station. The acceleration caused by this gravity can be calculated by the formula  $N = \frac{1}{6.28} \sqrt{\frac{a}{r}}$ , where  $N$  is the number of rotations per second,  $a$  is the acceleration caused by the artificial gravity in metres per second squared, and  $r$  is the radius of the station in metres.

31. An equivalent representation of the formula  $N = \frac{1}{6.28} \sqrt{\frac{a}{r}}$  is

- A.  $6.28N = \sqrt{\frac{a}{r}}$
- B.  $(6.28N)^2 = \left(\frac{a}{r}\right)^2$
- C.  $\frac{1}{\sqrt{6.28N}} = \sqrt{\frac{a}{r}}$
- D.  $\left(\frac{1}{6.28}N\right)^2 = \left(\frac{a}{r}\right)^2$

Use the following information to answer the next question.

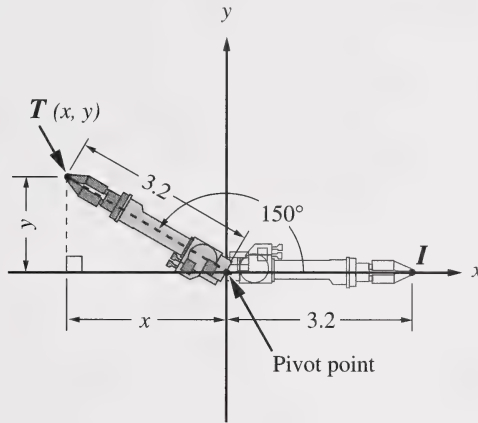
To simulate the handling of radioactive materials by astronauts in a space lab, students in the simulated space lab at the Space & Science Centre manipulate a robotic arm. The central axis of the arm portrayed by the graph of the function  $y = f(x)$  is moved to a new position portrayed by the transformed graph of the function  $y = f(x - h) + k$ , as shown below.



32. An equation that represents the transformed graph of the central axis of the arm above is
- A.  $y = f(x + 3) - 1$
  - B.  $y = f(x - 3) - 1$
  - C.  $y = f(x + 3) + 1$
  - D.  $y = f(x - 3) + 1$

Use the following information to answer the next question.

The robotic arm is also moved in a circular motion about its pivot point, so that the initial point  $I$  is moved to the terminal position  $T$ , as indicated on the coordinate plane shown below.



33. An equation that can be used to determine the  $x$ -coordinate of the terminal point  $T$  above is

- A.  $\cos 150^\circ = \frac{3.2}{x}$
- B.  $\sin 150^\circ = \frac{3.2}{x}$
- C.  $\cos 150^\circ = \frac{x}{3.2}$
- D.  $\sin 150^\circ = \frac{x}{3.2}$

Use the following information to answer the next question.

The electrical demand of the Space & Science Centre during a 24-hour period is shown below. The demand for electricity ( $P$ ) is related to the time of day ( $t$ ). The operation of electrical devices in the facility affects the amount of electricity used throughout the day.



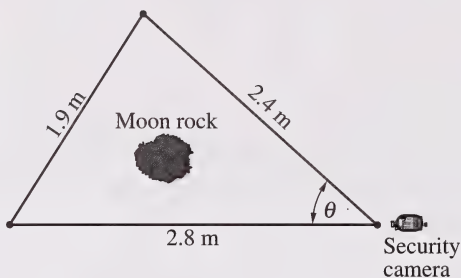
**Written Response — 5 marks**

- 4.** a. The base load is 60 kilowatts. Explain why it is not 0 kilowatts.

- c. Using numerical evidence from the graph, describe the changes in electrical demand that take place between 8:00 A.M. and 10:00 P.M. Include explanations of probable causes for these changes.

Use the following information to answer the next question.

To display a valuable specimen of moon rock, staff at the Space & Science Centre roped off a triangular area and installed a security camera, as shown below.



The security camera was installed so that it rotated continually between the two longest ropes through the angle  $\theta$ , as shown above.

34. The measure of angle  $\theta$ , to the nearest degree, is

A.  $38^\circ$   
B.  $42^\circ$   
C.  $43^\circ$   
D.  $52^\circ$

\_\_\_\_\_

Use the following information to answer the next question.

When 80 Grade 1 students visiting the Space & Science Centre were asked if there is life on Mars, 16 answered “no.”

35. Based on this sample, the 90% confidence interval for the percentage of all Grade 1 students who would answer “yes” to the question about life on Mars is between
- A. 54% and 73%  
B. 58% and 70%  
C. 70% and 90%  
D. 75% and 85%

*Use the following information to answer the next question.*

The table of values below shows the linear relationship between the number of students from schools visiting the Space & Science Centre on any given day and the total admission collected.

<b>Number of students visiting</b>	100	300	400	500
<b>Total admission collected from students</b>	\$375	\$1 125	\$1 500	\$1 875

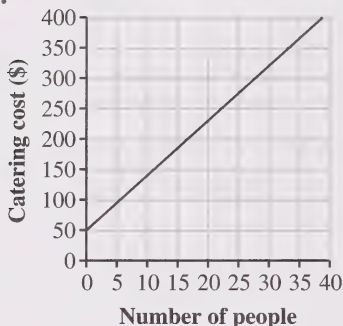
36. If, on any given day, the number of students visiting was between 0 and 600, then the total admission collected from students would be between
- A. \$0 and \$2 250
  - B. \$0 and \$1 875
  - C. \$375 and \$2 250
  - D. \$375 and \$1 875

Use the following information to answer the next question.

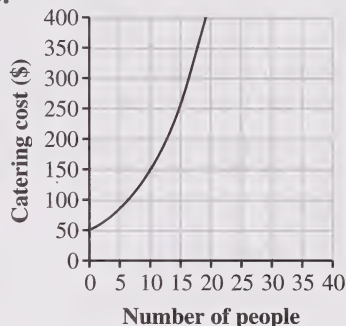
Staff at the Edmonton Space & Science Centre organize an annual reception for science teachers. The caterers providing the meal for the reception charge a flat rate of \$50 plus \$9 per person.

37. The graph below that illustrates the relationship between the catering cost and the number of people at the reception is

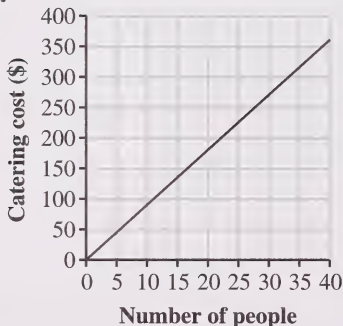
A.



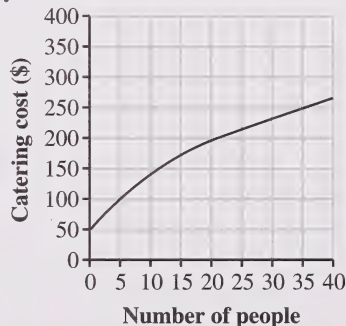
B.



C.



D.



*You have now completed the examination.  
If you have time, you may wish to check your answers.*

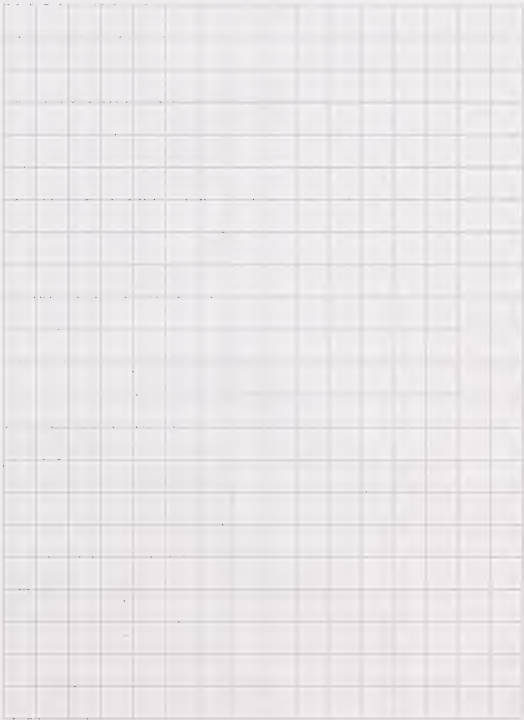
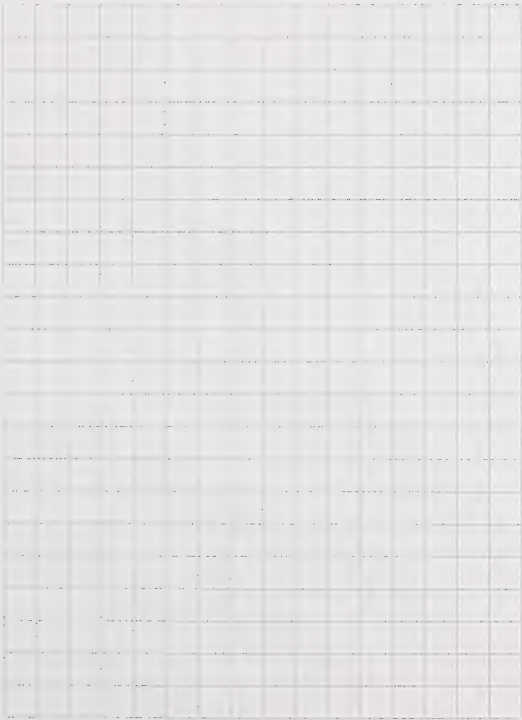
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